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13. ABSTRACT (Maximum 200 words)

Accomplishments and pertinent information under the Joint Services Electronics Program (JSEP) for the reporting period September 1992 - September 1995 are summarized. The JSEP program provides the research baseline for all three military services in the expanding electronic sciences requiring interdisciplinary efforts among sub-areas of electronicst. The central theme of this research is to resolve issues that have prevented wide spread use of millimeter-wave electronics. Considered are issues that have arisen primarily due to the lack ofd a coherent approach between solid state (device) research and electromagnetic (circuit and component) research. The device research takes into account the electromagnetic interaction with the circuit and the system environment while the millimeter-wave integrated circuit, as the electromagnetic system, considers the interaction with the solid state devices from the outset of analysis and design. Several research areas are synergistically combined. Research in the exploration of novel material systems and devices structures benefits from device simulation efforts. Novel integrated circuit configurations that exploit the best performance from the devices are studied. The devices and circuits are then implemented into quasi-optical monolithic arrays.

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Quasi-optical technique, multiplier, nonlinear transmission line, beam control, active antenna, FDTD, Stark effect, resonant tunneling diode, quantum well, heterojunction bipolar transistor	16. PRICE CODE

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FINAL REPORT
JOINT SERVICES ELECTRONICS PROGRAM

Research Contract AFOSR F49620-92-C-0055

For the period of September 1992 - September 1995

December 18, 1995

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(a) OVERVIEW OF ACCOMPLISHMENTS

The central theme of this program is to resolve bottleneck issues that have prevented wide spread use of millimeter-wave electronics. We consider that such bottlenecks have arisen primarily due to the lack of a coherent approach between solid state (device) research and electromagnetic (circuit and component) research. At millimeter-wave frequencies, devices and circuits cannot be analyzed, designed and tested separately due to wave interactions. Under this JSEP program, each unit interacted coherently and strongly. Although there are two units for solid state electronics and another two for electromagnetics, they worked together for several specific subjects such as quantum well devices with different aspects. Unit 1 (K. L. Wang) was concerned with the new integrable devices that were theoretically analyzed and simulated in Unit 2 (D. S. Pan). Unit 3 (T. Itoh) studied the millimeter-wave circuits in which these devices are treated as a part of the circuit in such a way that the optimum of the device capability is extracted. Under Unit 4 (N. C. Luhmann), quasi-optical configurations of the devices and circuits studied under the other units were implemented in complete systems.

Since the inception of the JSEP program at UCLA in September 1992, we have reached significant progress toward the above goal. Some of the significant accomplishments are as follows. (1) Optical control of double barrier Resonant Tunneling Diode (RTD) in which the negative resistance of the device can be externally controlled so that the initiation of the series connected RTDs may be accomplished by temporarily suppressing the negative resistance (Units 1, 2 and 3). (2) Electromagnetic simulation of the distributed gain mechanism was accomplished by incorporating the gain mechanism in the Finite Difference Time Domain (FDTD) algorithm. This technique was developed by Unit 3 with a direct impact on the device work under Units 1 and 2. (3) Stacked quantum barrier varactor frequency multiplier was invented and used in a quasi-optical system by Unit 4. The structure produced 5 W output at W band. (4) Unit 2 has discovered that the series integrated RTD's can be initiated by an injection signal at one half of the intended oscillation frequency (subharmonic oscillation). The injection signal is needed only for a short period of time and can be removed once the oscillation started. This prediction has also been demonstrated by Unit 3, by means of experiments using tunnel diodes that have the negative resistance characteristics similar to those of the RTD. During the experiment, it was found that the injection signal frequency need not be an integer fraction of the oscillation signal. (5) Coupled active antenna has been simulated by the extended FDTD. This is the first time that the microwave circuit was analyzed electromagnetically including the active devices. Unlike the standard network based approach, all the "electrically hidden" phenomena can be displayed visually as well as parametrically. Such understanding heavily relies on the device characterizations that can be provided by the solid state units while the output is useful in the system implementation work for Unit 4.

Several items on Technology Transfer have been reported in the three Annual Reports. They are: (1) Three-dimensional active integrated array antenna for which the design and structure have been provided to Hughes Aircraft. (2) Complete information on the electronically and optically activated beam control array in a quasi-optical manner has been provided to Hughes, Martin-Marietta, Northrop, Raytheon, Rockwell and TRW. (3) Electromagnetic simulation of the active integrated antenna has been transferred to Los Alamos National Laboratory with related information provided to CRAY, Research. In addition, the items (2) and (3) are now included in the proposal by Martin-Marietta for the ARPA program on MAFET (Microwave and Analog Front End Technology) under the Quasi-Optical Alliance. An extension of (3) to MMIC amplifiers is now being developed for a future CAD tool with Hughes Aircraft Company.

The Quasi-Optical structures being developed have recently found new applications as low cost alternative for wireless communications, at typically lower microwave frequencies such as C, S, X and Ku bands. One of these applications, the non-contact ID transponder card, was presented and demonstrated at the 1994 IEEE International Microwave Symposium. Subsequently, several industrial companies have inquired about potential productization. One of the latest was Select University Technologies, Inc. At the same time, we received an invitation from *Microwave Journal* to write an article "Quasi-optical Microwave Circuits for Wireless Applications in a feature section. The article will also appear in *Telecommunications*. Together, the total circulation is 130,000 worldwide. As soon as this article appeared, we received an inquiry from Vehicular Security Electronics, Inc. for assistance in their product of a wireless motion sensor.

In closing, this three year period has been a very rewarding experience for all of the personnel involved in this JSEP program. Significant advances have been witnessed in the basic research for understanding of many bottleneck issues and some solutions for them. Even though the emphasis of the program is of the high risk and high payoff type, emphasizing the basic research, we have found many technology transitions to industry and other organizations for further development and productization.

Tatsuo Itoh and Neville C. Luhmann, Jr.

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Professor T. Itoh	310-206-4820
Proessor N. C. Luhmann, Jr.	510-422-9787

(c) DEGREES AWARDED

Master of Science (Supervisor)

J. Y.-Y. Liao	(Luhmann)	1993
S. Y. Shu	(Luhmann)	1993
R. Hsia	(Luhmann)	1993
E. Chung	(Luhmann)	1993
W. Geck	(Luhmann)	1993
T. Liu	(Luhmann)	1993
S. Cheng	(Luhmann)	1993

Doctor of Philosophy (Supervisor)

L. Sjogren	(Luhmann)	1993
H.-X. Liu	(Luhmann)	1993
S. Khorram	(Wang)	1994
B. Toland	(Itoh)	1994
J. Lin	(Itoh)	1994
H. S. Li	(Wang)	1994
O. Boric-Lubecke	(Itoh)	1995
X. Qin	(Luhmann)	1995

(d) LIST OF JSEP PUBLICATIONS

Unit 1, "Investigation of Novel Devices and Concepts" (Prof. K. L. Wang)

I. LIST OF JOURNAL PUBLICATIONS

1. H. S. Li, Y. W. Chen, K. L. Wang, and D. Y. C. Lie, "Intersubband transitions in pseudomorphic InGaAs/GaAs/AlGaAs multiple step quantum wells," J. Vac. Sci. Technol. B, 11, 1840 (1993).

2. S. Khorram, K. L. Wang, T. Block, and D. Streit, "Carrier transport in GaAs/AlGaAs heterostructures by microwave time-of-flight technique," Appl. Phys. Lett. 63, 3491 (1993).

3. J. Jo, H. S. Li, Y. W. Chen, and K. L. Wang, "Observation of a large capacitive current in a double barrier resonant tunneling diode at resonance," Appl. Phys. Lett. 64, 2276 (1994).

4. H. S. Li, Y. W. Chen, K. L. Wang, and D. S. Pan, "Dominant photogenerated valley current in a double-barrier resonant-tunneling diode," Appl. Phys. Lett. 65, 2999-3001 (Dec 1994).

5. Y. W. Chen, H. S. Li, Z. Zhou, and K. L. Wang, "Transfer matrix analysis of waveguide phase modulator using the linear electrooptic effect of asymmetric quantum wells," J. of Appl. Phys, 76, 4903 (1994).

LIST OF CONFERENCE PROCEEDINGS

1. H. S. Li, R. P. G. Karunasiri, Y. W. Chen, and K. L. Wang, "Electron intersub-band normal incidence absorption in InGaAs/GaAs quantum wells", May/June, 1993 J. Vacuum Science Tech. B.

2. H. S. Li, L. P. Chen, Y. W. Chen, K. L. Wang, D. S. Pan, and J. M. Liu, "Dominant photogenerated valley current in a double barrier resonant tunneling diode", J. Vac. Sci. Technol. B, March/April 1994.

Unit 2, "Modeling and Theoretical Exploration of Millimeter Wave Solid State Devices" (Prof. D. S. Pan)

I. LIST OF JPUBLICATIONS (*JSEP supported in whole or in part)

1. P. Man and D.S. Pan ,"Analysis of Normal-Incident Absorption in P-type Quantum-Well Infrared Detectors". Appl. Phys. Lett. 61, 2799, Dec. 92.

2. P. Huang, D. S. Pan, and N. C. Luhmann, Jr. " A Microwave Measurement Technique for Characterizing the I-V relationship for Negative Differential Conductance Devices," IEEE Transactions on Microwave Theory and Tech., MTT-41(8), 1455, August, 1993.

3. P. Man and D. S. Pan " Analysis of Normal-Incident Absorption in a Proposed p-type Very-Narrow-Quantum-Well Infrared Photodetector" Appl. Phys. Lett., 64(3), 321, January, 1994.

*4. O. Boric-Lubecke, D. S. Pan, and T. Itoh, "RF excitation of an oscillator with several tunneling devices in series," IEEE Microwave and Guided Wave Lett., Vol. 4, pp. 364-366, Nov. 1994.

*5. O. Boric-Lubecke, D. S. Pan, and T. Itoh, "Fundamental and subharmonic excitation for an oscillator with several tunneling diodes in series," IEEE Trans. Microwave Theory Tech., vol. 43, pp. 969-976, April, 1995.

*6. H. S. Li, L. P. Chen, Y. W. Chen, K. L. Wang, D. S. Pan, J. M. Liu, "Dominant photogenerated valley current in a double-barrier resonant-tunneling diode," Appl. Phys. Lett. Vol. 65, pp. 2999-3001, Dec. 1994.

*7.P. Man and D. S. Pan, "Hot-carrier-temperature model for the dark current of quantum-well infrared photodetectors," Appl. Phys. Lett. Vol. 66, pp. 192-194, January 1995.

*8. R. Sun, D. S. Pan, and T. Itoh, "Simulation of a subharmonic excitation of series integrated resonant tunneling diodes," IEEE Microwave and Guided Wave Lett., Vol. 5, pp.18-20, Jan. 1995.

*9. C. C. Yang and D. S. Pan, "A theoretical study of an integrated quantum well resonant tunneling oscillator initiated by an IMPATT diode," IEEE Trans. Microwave Theory Tech., Vol. MTT-43, 112-118, 1995.

II. LIST OF CONFERENCE PROCEEDINGS (*JSEP Supported in whole or in part)

1. O.B. Lubecke, D.S. Pan, T. Itoh, "Millimeter Wave Oscillators with Several Tunneling Devices in Series" presented at URSI conference, January, 1993, Boulder, Colorado.

2. C.C. Yand and D.S. Pan, "Millimeter-Wave Simulation of a Series-Integrated Resonant Tunneling Diode Including Transit Time Effect" presented in IEEE MIT-S, International Microwave Symposium, June 14-18, 1993, Atlanta.

3. O.B. Lubecke, H.S. Li, D.S. Pan, KL. Wang, T. Itoh, "Series Integration of Quantum-Well Diodes: Millimeter Wave Oscillator Design and Excitation", XXIV The General Assembly of International Union of Radio Science, Kyoto, Japan. September 1993.

4. W. Liu and D.S. Pan, "A New Discretization Scheme for the Energy Transport Equation" presented at NASCODE IX 1993 Conference, April 6-8, 1993, Copper Mountain, Colorado.

5. B. Toland, D.S. Pan and T. Itoh, "Analysis of a Multiple Layer Traveling Wave Device," 23rd European Microwave Conference, Madrid, Spain. September 6-9, 1993.

6. Olga Boric-Lubecke, D.S. Pan, T. Itoh, "Large Signal Quantum-well Oscillator Design," 23rd European Microwave Conference, Madrid, Spain. September 6-9, 1993.

7. O. Boric-Lubecke, R. Sun, D. S. Pan and T. Itoh " Excitation of an Oscillator with Several Resonant tunneling Devices Integrated in Series Using RF source" Fifth International Symposium on Space Terahertz Technology, May 10-12, 1994, the University of Michigan, Ann Arbor, Michigan.

8. D. S. Pan and A. Man " Theoretical Analysis of P-type Quantum Well Detectors" (Invited) Second International Symposium on 2-20 um Wavelength Infrared Detectors and Arrays: Physics and Applications, October 9-14, 1994 Miami Beach, Florida.

*9. O. Boric-Lubecke, D. S. Pan and T. Itoh, "Fast electric pulse excitation of an oscillator with several tunneling devices in series," 24th European Microwave Conference, pp. 782-787, Sept. 5-8, 1994, France.

*10. P. Man and D. S. Pan, "Theoretical investigation of p-type optical interaction in p-type quantum well infrared detectors", (Invited paper), Proceedings of the Second International Symposium on Long Wavelength Infrared Detectors and Arrays: Physics and Applications, pp. 139-163, 199, edited by V. Swaminathan, S. Li, T.S. Faska, H.C. Liu, and F. Radpour, the Electrochemical Society.

*11.O. Boric-Lubecke, D. S. Pan, and T. Itoh, " Oscillation amplitude and frequency limitations for an oscillator with several tunneling devices in series," 19th International conference on Infrared and Millimeter Waves, pp. 17-18, October 17-20, 1994, Sendai, Japan.

Unit 3, " Wave Interactions in Active Integrated Circuits" (Prof. T. Itoh)

I. LIST OF PUBLICATIONS (* JSEP Supported in whole or in part)

1. J. Lin, C.-Y. Chang, Y. Yamamoto and T. Itoh, "Progress of tunable active bandpass filter," Annales des Telecommunications (Special Issue), Vol.47, No.11-12, pp.499-507, November December 1992.

2. T. Hirota and T. Itoh, Coupling between slotlines through a conductor backing," IEEE Microwave and Guided Wave Letters, Vol.3, No.2, pp.40-41, February 1993.

3. S. Kawasaki and T. Itoh, "2 x 2 Quasi-Optical Power Combiner Array at 20 GHz," IEEE Trans. Microwave Theory and Techniques Vol. 41 No. 4 (April 1993): pp. 717-719.

4. T.-W. Huang and T. Itoh, "The Influence of Metallization Thickness of the Characteristics of Cascaded Junction Discontinuities of Shielded Coplanar Type Transmission Line," EEE Trans. Microwave Theory and Techniques Vol. 41 No. 4 (April 1993): pp. 693-697.

5. B. Toland and T. Itoh, "Boundary Element Analysis of a Trapezoidal Transmission Line," IEEE Trans. Microwave Theory and Techniques Vol. 41 No. 6 June 1993): pp. 1052-1056.

6. B. Houshmand, T.-W. Huang, and T. Itoh, "Microwave Structure Characterization by a Combination of FDTD and System Identification Methods," IEEE Microwave and Guided Wave Letters Vol. 3 No. 8 (August 1993): pp. 262-264.

*7.B.Toland, B. Houshmand, and T. Itoh, "Modeling of Nonlinear Active Regions with the FDTD Method," IEEE Microwave and Guided Wave Letters Vol. 3 No. 9 (September 1993): pp. 333-335.

8. A. M. Tran and T. Itoh, "Full Wave Modeling of Coplanar Waveguide Discontinuities with Finite Conductor Thickness," IEEE Trans. Microwave Theory and Techniques Vol. 41 No. 9 (September 1993): pp. 1611-1615.

9. Y. Liu and T. Itoh, "Characterization of Power Dependent High-Tc Superconducting Microstrip Line by Modified Spectral Domain Method," Radio Science Vol. 28 No. 5 (September-October 1993): pp. 913-918.

10.S. Nogi, J. Lin, and T. Itoh, "Mode Analysis and Stabilization of a Spatial Power Combining Array with Strongly Coupled Oscillators," IEEE Trans. Microwave Theory and Techniques Vol. 41 No. 10 (October 1993): pp. 1827-1837.

11. S. Kawasaki, and T. Itoh, "Quasi-Optical Planar Arrays with FETs and Slots," IEEE Trans. Microwave Theory and Techniques Vol. 41 No. 10 (October 1993): pp. 1838-1844.

*12. T.-W. Huang, B. Houshmand, and T. Itoh, "Fast Sequential FDTD Diakoptics Method Using the System Identification Technique," IEEE Microwave and Guided Wave Letters Vol. 3 No. 10 (October 1993): pp. 378-380.

13. D.-C. Niu, T. Yoneyama, and T. Itoh, "Analysis and Measurement of NRD-Guide Leaky Wave Coupler in Ka Band," IEEE Trans. Microwave Theory and Techniques Vol. 41 No. 12 (December 1993): pp. 2126-2132.

*14. J. Lin and T. Itoh, "Two-Dimensional Quasi-Optical Power-Combining Arrays Using Strongly Coupled Oscillators," IEEE Trans. Microwave Theory and Techniques: Special Section on Space Terahertz Technology, Vol. 42, No. 4(April1994): pp. 734-741.

*15. O. Boric-Lubecke, O., D. S. Pan and T. Itoh, "RF excitation of an oscillator with several tunneling devices in series," IEEE Microwave and Guided Wave Letters, Vol.4, No.11, (November 1994), pp.364-366.

16. S. Kawasaki and T. Itoh, "Millimeter-Wave Active Integrated Antennas Utilizing Harmonics," IEICE Trans. C-I, Vol.J77-C-I, No.11, pp.607-616, November 1994.

17. S. Kawasaki and T. Itoh, "Optical Control of Active Integrated Antennas Using Microwave - Optical Interaction," IEICE Trans. C-I, Vol.J77-C-I, No.11, pp.671-678, November 1994.

18. *Huang, T.-W., B. Houshmand, and T. Itoh, "The Implementation of Time Domain Diakoptics in the FDTD Method," EEE Trans. Microwave Theory and Techniques Vol. 42 No. 11 (November 1994): pp. 2149-2155.

*19. J. Lin, and T. Itoh, "Active Integrated Antennas," IEEE Trans. on Microwave Theory and Techniques Vol. 4, No. 12 (December 1994): pp. 2186 -2194.

*20. C. W. Pobanz and Itoh T, "Quasi-optical Microwave Circuits for Wireless Applications," Microwave Journal Vol. 38. No 1 (January 1995): pp. 64-85.

*21. R. Sun, D.-S. Pan and T. Itoh, "Simulation of a Subharmonic Excitation of Series Integrated Resonant Tunneling Diodes," EEE Microwave and Guided Wave Letters 5 1 (January 1995): pp. 18-20.

22. J. Lin and T. Itoh, "Experiment of Device Failures in a Spatial Power Combining Array," EEE Trans. Microwave Theory and Techniques Vol. 43 No. 2 (February 1995): pp. 267-271.

*23.O. Boric-Lubecke, D.-S. Pan, and T. Itoh, "Fundamental and Subharmonic Excitation for an Oscillator with Several Tunneling Diodes in Series," Microwave Theory and Techniques Vol. 43 No.4 (April 1995): pp. 969-976.

24. Y. Liu, K. Cha, and T. Itoh, "Non-Leaky Coplanar (NLC) Waveguides with Conductor Backing," IEEE Trans. on Microwave Theory and Techniques, Vol.43, No.5, pp.1067-1072, May 1995.

24. S. Basu, S. A. Maas and Itoh T, "Piecewise Stability Analysis in Microwave Circuits," IEEE Microwave and Guided Wave Letters Vol. 5 No.5 (May 1995): pp. 159-160.

*25. C. W. Pobanz and T. Itoh, "A Microwave Non-Contact Identification Transponder Using Subharmonic Interrogation," IEEE Microwave Theory and Tech., Special Issue on Commercial and Consumer Circuits, Systems and Applications, Vol. 43, No. 7 (July 1995) pp.1673-1679.

*26. Kuo, C.N., Thomas, V.A, Chew, S.T., Houshmand, B., Itoh, T., "Small Signal Analysis of Active Circuits Using FDTD Algorithm," IEEE Microwave and Guided Wave Letters, Vol.5, No.7, (July 1995), pp.216-28.

27. M. Minegishi, J. Lin, and T. Itoh, "Control of Mode-Switching in an Active Antenna Using MESFET," EEE Trans. on Microwave Theory and Techniques, Vol. 43, No. 8, (August 1995) pp. 1869-1874..

II. LIST OF CONFERENCE PROCEEDINGS (*JSEP Supported in whole or in part)

1. T. Itoh, "Modeling of millimeter wave structures," (Invited) International Symposium on Signals, Systems and Electronics, pp.64-65, September 1-4, 1992, Paris, France.

2. Toland and T. Itoh, "Full wave boundary element analysis with removal of spurious modes," International Symposium on Signals, Systems and Electronics, pp.74-76, September 1-4, 1992, Paris, France.

3. S. Kawasaki and T. Itoh, "Active integrated antenna based on slots and FETs," International Symposium on Signals, Systems and Electronics, pp.584-587, September 1-4, 1992, Paris, France.

4. T. Hirota and T. Itoh, "Recent progress in filters for mobile communication systems," (Invited) International Symposium on Signals, Systems and Electronics, pp.856-858, September 1-4, 1992, Paris, France.

5. S. Kawasaki and T. Itoh, "Electronically and optically controlled active integrated antenna," 1992 International Symposium on Antennas and Propagation, pp.821-824, September 22-25, 1992, Sapporo, Japan.

6. S. Kawasaki and T. Itoh, "Quasi-optical and active antenna technology," MM92 Conference, pp.311 -316, October 14- 15, 1992, Brighton, England.

7. S. Kawasaki and T. Itoh, "Progress of optical control of quasi-optical oscillators using MESFETs," Seventeenth International Conference on Infrared and Millimeter Waves, pp.354 355, December 14-17, 1992, Pasadena, CA.

*8. O.Boric-Lubecke, D.S. Pan and T. Itoh, "Millimeter wave oscillators with several tunneling devices in series," National Radio Science Meeting, p.92, January 5-8, 1993, Boulder, CO.

9. B. Houshmand and T. Itoh, "Parameter estimation for characterization of microwave structures," National Radio Science Meeting, p.134, January 5-8, 1993, Boulder, CO.

*10. J. Lin, and T. Itoh, "Comparison of a 4-Element Linear Array and a 2 x 2 Planar Array," Proceedings of Fourth International Svmposium on Space Terahertz Technology, Los Angeles, California: March 30-April 1, 1993, pp. 94-103.

*11. S.Kawasaki and T. Itoh, "Optical Tuning Range Comparison of Uniplanar Active Integrated Antenna Using MESFET, GaAs HEMT and Pseudomorphic HEMT," Proceedings of Fourth International Svmposium on Space Terahertz Technology, Los Angeles, California: March 30-April 1, 1993, pp. 149-156.

*12. J. Lin, S. Kawasaki, and T. Itoh, "Optical Control of MESFETs for Active Filter and Active Antenna," Proceedings of MIOP '93, Sindelfingen, Germany: May 25-27, 1993, pp. 348-352.

13. Niu, D.-C., T. Yoneyama, and T. Itoh, "Measurement of NRD-Guide Leaky Wave Coupler in Ka Band," IEEE MTT-S International Microwave Svmposium Digest, Atlanta, Georgia: June 15-17, 1993, pp. 1207-1210.

14. Y. Liu, T. Hirota, and T. Itoh, "Coupling Phenomena in Conductor-Backed Slotline Structure," IEEE MTT-S International Microwave Svmposium Digest, Atlanta, Georgia: June 15-17, 1993, pp. 1203-1206.

*16. T. W. Huang, B. Houshmand, and T. Itoh, "The FDTD Diakoptics Method," IEEE MTT -S International Microwave Svmposium Digest, Atlanta, Georgia: June 15-17, 1993, pp. 1435-1438.

*17. J. Lin, and T. Itoh, "A 4 x 4 Spatial Power-Combining Array with Strongly Coupled Oscillators in Multilayer Structure," International Microwave Svmposium Digest, Atlanta, Georgia: June 15-17, 1993, pp. 607-610.

18. A. M. Tran and T. Itoh, "Analysis of Microstrip Line Coupled Through an Arbitrarily Shaped Aperture in a Thick Common Ground Plane," IEEE M77-S International Microwave Svmposium Digest, Atlanta, Georgia: June 15-17, 1993, pp. 819-822.

*19. S. Kawasaki and T. Itoh, "Optical Control on 2-Element CPW Active Integrated Antenna Array with Strong Coupling," I 993 IEEE AP-S Svmposium Digest, Ann Arbor, Michigan: June 28 - July 2, 1993, pp. 1616-1619.

*20. J. Lin, T. Itoh, and S. Nogi, "Mode Switch in a Two-Element Active Array," 1993 IEEE AP-S Svmposium Digest, Ann Arbor, Michigan: June 28 - July 2, 1993, pp. 664

*21. T. W. Huang, B. Houshmand, and T. Itoh, "The FDTD Wide-Band Absorbing Boundary Conditions for the Excitation Plane," 1993 IEEE AP-S Svmposium Digest, Ann Arbor, Michigan: June 28 - July 2, 1993, pp. 2-5.

*22. O. Boric-Lubecke and T. Itoh, "Optical Illumination of Series Integrated Resonant Tunneling Diodes," URSI Digest, Ann Arbor, Michigan: June 28 - July 2, 1993, p. 96.

23. J. Lin, S. Kawasaki, and T. Itoh, "Quasi-Optical Linear Arrays," Proceedings of PIERS '93, Pasadena, California: July 12-16, 1993, p. 834.

24. B. Houshmand, T.W. Huang, and T. Itoh, "Efficient Analysis of Planar Microwave Structures by FDTD Diakoptics and Parameter Estimation," Proceedings of PIERS '93, Pasadena, California: July 12-16, 1993, p. 369.

25. M. C. Wu, and T. Itoh, "Ultrafast Photonic-to-Microwave Transformer (PMT)," Proceedings of LEOS Summer Topical Meeting on Optical Microwave Interactions, Santa Barbara, California: July 19-21, 1993, pp. 63-64.

*26. T. Itoh, "Role of Electromagnetics for Practical Problems," Proc. ARO Workshop on Dual Use Millimeter-Wave Technologies, Kyoto, Japan: August 28-29, 1993, Paper 3-2.

27. S. Kawasaki and T. Itoh, "Topology of Active Integrated Antenna," Proceedings of XXIVth URSI General Assembly, Kyoto, Japan: August 23 - September 3, 1993, p.133.

28. S. Kawasaki, and T. Itoh, "Optical Control of 2-Element Uniplanar HEMT Active Integrated Antenna Array," Proceedings of XXIVth URSI General Assembly, Kyoto, Japan: August 23 - September 3, 1993, p. 567.

*29. O. Boric-Lubecke, et al., "Series Integration of Quantum-Well Diodes: Millimeter Wave Oscillator Design and Excitation," Proceedings of XXIVth URSI General Assembly, Kyoto, Japan: August 23 - September 3, 1993, p. 174.

*30. T. W. Huang, B. Houshmand, and T. Itoh, "Applications of System Identification Technique to FDTD and FDTD Diakoptics Method," Proceedings of 23rd European Microwave Conference, Madrid, Spain: September 6-9, 1993, pp. 278-280.

31. S. Kawasaki and T. Itoh, "Second Harmonic Uniplanar Active Integrated Array with Strong Coupling," Proceedings of 23rd European Microwave Conference, Madrid, Spain: September 6-9, 1993, pp. 204-206.

*32. O. Boric-Lubecke, D.S. Pan, and T. Itoh, "Large Signal Quantum-Well Oscillator Design," Proceedings of 23rd European Microwave Conference, Madrid, Spain: September 6-9, 1993, pp. 817-818.

33. A. M. Tran and T. Itoh, "Open-Ended Microstrip Lines Coupled Through an Arbitrary Aperture in a Thick Common Ground Plane," Proceedings of 23rd European Microwave Conference, Madrid, Spain: September 6-9, 1993, p. 435.

*34. J. Lin and T. Itoh, "Analysis of Device Failures in a Power-Combining Array," Proceedings of 23rd European Microwave Conference, Madrid, Spain: September 6-9, 1993, pp.912-913.

35. B. Toland, D.S. Pan, and T. Itoh, "Analysis of a Multiple Layer Traveling Wave Device," Proceedings of 23rd European Microwave Conference, Madrid, Spain: September 6-9,1993.

*36. J. Lin and T. Itoh, "Active Integrated Antennas for Power Combining and Beam Control," Proceedings of The Workshop on Millimeter-Wave Power Generation and Beam Control, Huntsville, Alabama: September 14-15,1993.

*37. J. Lin and T. Itoh, "Active Antennas and Quasi-Optical Power Generation," Proceedings of 1993 Microwave Workshops and Exhibition, Tokyo, Japan: September 20-22,1993, pp.149-152.

38. T. Itoh, "Expanding Opportunities of Microwave Engineering," Proceedings of MWE '93, Tokyo, Japan: September 20-22,1993, pp.3-7.

39. S. Kawasaki and T. Itoh, "Uni-Planar Active Integrated Antenna Element with Tuning Stub Using a FET and CPW's," Proceedings of 1993 Asia-Pacific Microwave Conference, Hsinchu, Taiwan: October 18-21,1993, pp.1.5-1.8.

*40. J. Lin, S. Nogi, and T. Itoh, "Frequency Tuning of a Spatial Power Combining Array Using Strongly Coupled Oscillators," Proceedings of 1993 Asia-Pacific Microwave Conference, Hsinchu, Taiwan: October

*41. T. W. Huang, B. Houshmand, and T. Itoh, "The Sequential FDTD Diakoptics Method for Modular Computation," Proceedings of 1993 Asia-Pacific Microwave Conference, Hsinchu, Taiwan: October 18-21,1993, pp.9.17-9.20.

42. B. Houshmand, and T. Itoh, "Enhanced Finite Difference Time Domain (FDTD) Method for Active and Passive Structures," Proceedings of Second International Workshop on Discrete Time Domain Modeling of Electromagnetic Fields and Networks Session Al, Berlin, Germany: October 28-29, 1993.

*43 B. Toland, D.S. Pan, and T. Itoh, "Electromagnetic Wave Propagation Through Layered Microwave and Millimeter Wave Devices," Proceedings of 1993 International Semiconductor Device Research Svmposium, Charlottesville, VA: December 1-3, 1993, Paper T3A-8.

44. B. Houshmand, O. Boric-Lubecke, and T. Itoh, "Time Domain Characterization of Whisker Contact," Proceedings of National Radio Science Meeting, Boulder, CO: January 5-8, 1994.

45. B. Houshmand and T. Itoh, "3D FDTD Characterization of Complex Microwave Structures," Proceedings of National Radio Science Meeting, Boulder, CO: January 5-8, 1994.

46. T.-W. Huang and T. Itoh, "FDTD Numerically Exact Absorbing Boundary Conditions for the Dominant Mode in a Shielded Waveguide," Proceedings of National Radio Science Meeting, Boulder, CO: January 5-8, 1994, p. 236.

*47. B. Houshmand and T. Itoh, "Future of Electromagnetics for Millimeter Wave Circuit Design," Proceedings of SPIE Critical Review on Millimeter and Microwave Engineering for Communications and Radar, San Diego, CA: January 1~14, 1994.

*48. O. Boric-Lubecke, et al., "Excitation of an Oscillator with Several Resonant Tunneling Devices Integrated in Series Using RF Source," Proceedings of Fifth International Svmposium on Space Terahertz Technology, Ann Arbor, Michigan: (University of Michigan), May 10-12, 1994, pp. 735 - 741.

49. Y. Liu and T. Itoh, "Control of Leakage in Multilayered Conductor-Backed Coplanar Structures," Proceedings of IEEE MTT-S International Microwave Svmposium, San Diego, CA: May 23-27, 1994.

50. K. Cha, S. Kawasaki, and T. Itoh, "Transponder Using Self-Oscillating Mixer and Active Antenna," Proceedings of IEEE M77-S International Microwave Symposium, San Diego, CA: May 23-27, 1994, pp. 425 - 42~.

*51. T.-W. Huang, B. Houshmand, and T. Itoh, "Efficient Modes Extraction and Numerically Exact Matched Sources for a Homogeneous Waveguide Cross-Section in a FDTD Simulation," Proceedings of 1994 IEEE MTT-S International Microwave Svmposium, San Diego, CA: May 23-27, 1994, pp. 31 - 34.

*52. B. Toland, et al., "Electromagnetic Simulation of Mode Control of a Two Element Active Antenna," Proceedings of IEEE MTT-S International Microwave Symposium, San Diego, CA: May 23-27, 1994, pp. 883 - 886.

*53. J. Lin, S.T. Chew, and T. Itoh, "A Unilateral Injection-Locking Type Active Phased Array for Beam Scanning," Proceedings of IEEE M77-S International Microwave Svmposium, San Diego, CA: May 23-27, 1994, pp.1231 - 1234.

*54. T. Itoh, "New Trends and Ideas in the Fields of Microwave Technology," Proceedings of MIKON 94, Poland: May 30-June 2, 1994, pp. 3-9.

55. B. Houshmand, B. Toland, and T. Itoh, "Far Field Computation of Active Antennas," Proceedings of 1994 URSI Radio Science Meeting, Seattle, WA: June 20-24, 1994, pp. 4

*56. T.-W. Huang, B. Houshmand, and T. Itoh, "Efficient FDTD Wideband Matched Sources for a Homogeneous Waveguide Cross-Section," Proceedings of 1994 IEEE AP International Symposium, Seattle, WA: June 20-24, 1994, pp. 1434 - 1437.

*57. B. Houshman, B. Jalali, and T. Itoh, "Toward Unified CAD for Active Microwave and Millimeter Wave Circuits and Radiating Systems," Proceedings of 1994 IEEE AP-S/URSI Meeting, June 20-24, 1994, pp. 124.

* 58. B. Houshmand and T. ltoh, "Analysis and Visualization of Microwave Propagation in Planar Structures by the Enhanced FDTD Method," Proceedings of PIERS 1994, Nooedwijk, Netherlands: July 11 - 15, pp.

*59. T. Itoh, "Future Trend in Electromagnetic Analysis of Microwave Circuits Containing Active Devices," Proceedings of IEICE Microwave Group Meeting, Sapporo, Japan: July 18, 1994, pp. 33 - 38.

*60. M. Minegishi, J. Lin, and T. Itoh, "Mode Switching in an Active Antenna Using Reactive FET," Proceedings of 24th European Microwave Conference, Cannes, France: Sept. 5-8, 1994, pp. 1127 -1130.

*61. S. Kawasaki and T. Itoh, "Optical Interaction of Active Integrated Antennas (invited paper)," Proceedings of 24th European Microwave Conference, Cannes, France: September 5-8, 1994, pp. 185 - 193.

*62. O. Boric-Lubecke, D.-S. Pan, and T. Itoh, "Fast Electric Pulse Excitation of an Oscillator with Several Tunneling Devices in Series," Proceedings of 24th European Microwave Conference, France: Sept. 5-8, 1994, pp. 782 - 787.

*63. O. Boric-Lubecke D.-S. Pan, and T. Itoh, "Oscillation Amplitude and Frequency Limitations for an Oscillator with Several Tunneling Devices in Series," Proceedings of 19th International Conference on Infrared and Millimeter Waves, Sendai, Japan: Oct. 17 20, 1994, pp. 17-18.

64. S. T. Chew, et al., "Microwave-Optical Integration in Active Phased Array," Proceedings of Optical Microwave Interactions, France: November 21 - 23, 1994, pp.

*65. T. Itoh, "Millimeter Wave Circuit Design Technology as Electromagnetic Engineering," Proceedings of 1994 Asia-Pacific Microwave Conference, Tokyo, Japan: Dec. 6-9, 1994, pp. 25-30.

*66. M. Minegishi, J. Lin, and T. Itoh, "Electronic and Optical Control of MESFET for Mode-switching in an Active Antenna," Proceedings of 1994 Asia Pacific Microwave Conference, Tokyo, Japan: Dec. 6-9, 1994, pp. 963-966.

*67. Y. Liu and T. Itoh, "Engineering Applications of Electromagnetic Leakage Phenomena in Microwave Integrated Circuits," Proceedings of National Radio Science Meeting, Boulder, CO: January 3-7, 1995, pp. 46.

*68. C. N. Kuo, B. Houshmand, and T. Itoh, "Simulation of Microwave Circuits by FDTD Method," Proceedings of National Radio Science Meeting, Boulder, CO: January 3-7, 1995, pp. 245.

*69. O. Boric-Lubecke, D.S. Pan, and T. Itoh, "Effect of the Increased Number of Diodes on the Performance of Oscillators with Series-Connected Tunnel Diodes," Proceedings of Sixth International Svmposium On Space Terahertz Technology, Pasadena, CA: March 21-23, 1995.

70. S. T. Chew, and T. Itoh, " A 2x2 Beam-switching Active Antenna Array," Proceedings of MTT-S, Orlando, Fl: May 14-19, 1995, pp. 925-928.

71. T. Itoh, "3D Characterizations of Active Antenna Structures for Quasi-Optical Systems," Proceedings of MTT-S Workshop, Orlando, FL: May 14-19, 1995.

*72. C. N. Kuo, et al., "FDTD Simulation of a Microwave Amplifier," Proceedings of MTT-S International Microwave Svmposium, Orlando, FL: May 14-19,1995, pp. 357-360.

73. C. Y. Lee, Y. Liu, and T. Itoh, "Study of Non-leaky coplanar (NLC) Waveguide Discontinuities," Proceedings of MTT-S, Orlando, FL: May 14-19, 1995, pp237-240.

*74. C. W. Pobanz and T. Itoh, "A Conformal Retrodirective Array for Radar Applications Using a Heterodyne Phased Scattering Element," Proceedings of MTT-S International Microwave Svmposium, Orlando, FL: May 14-19, 1995, pp905-908.

*75. S. T. Chew, et al., "Active Antenna Array with Optical Interaction for Application in Radar System," Proceedings of NTC '95, Orlando, FL, (IEEE), May 16-20, 1995, pp. 1221-1224.

*76. B. Houshmand and T. Itoh, "Application of FDTD Method to Microwave Circuits," Proceedings of International Svmposium on Electromagnetic Theory, St. Petersburg, Russia: May 23-26, 1995, pp. 557-559.

*77. S. T. Chew and T. Itoh, "Application of Injection-locking to Beam-switching Active Antenna Array," Proceedings of MIOP'95, Sindelfingen, Germany: May 29-June 2, 1995, pp. 560-562.

*78. C. W. Pobanz and T. Itoh, "An Active Quasi-Optical Mixer for Transponder Applications," Proceedings of MIOP'95, Sindelfingen, Germany: May 29-June 2, 1995, pp.575-579.

*79. S. T. Chew, et al., "An Active Tracking Doppler Transceiver With Active Optical Link," Proceedings of Summer Topicals 1995, Keystone, Colorado, (IEEE), August 7-11 1995,pp. 70-71.

80. C. N. Kuo, B. Houshmand, and T.Itoh, "FDTD Analysis of Active Circuits with Equivalent Current Source Approach," Proceedings of IEEE-AP-S, Newport Beach, CA, (IEEE), June 18-23 1995, pp.1510-1513.

81. S. T. Chew and T. Itoh, "Analysis of MESFET Self-Oscillating Mixer Using Volterra Series," 25th European Microwave Conference, September 4-7, 1995, Bolgna, Italy, pp.1129-1132.

Unit 4, "Millimeter Wave Array and System Development (Prof. N. Luhmann)

I. LIST OF JSEP PUBLICATIONS (*JSEP Supported in Whole or in Part)

1. X-H. Qin, C.W. Domier, N.C. Luhmann, Jr., H-X.L. Liu, E. Chung and L. Sjogren, "Millimeter-Wave Monolithic Barrier-N-N+ Diode Grid Frequency Doubler," Applied Physics Letters, 62, 1650, April 1993.

*2. L.B. Sjogren, H-X.L. Liu, T. Liu, F. Wang, C.W. Domier and N.C. Luhmann, Jr., "Control Techniques for Millimeter-Wave Active Arrays," International Journal of Infrared and Millimeter Waves, 14, 1175, June 1993.

*3. L.B. Sjogren, H-X.L. Liu, X-H. Qin, C.W. Domier and N.C. Luhmann, Jr., "Electronic and Electromagnetic Devices for Millimeter-Wave Beam Control Arrays," International Journal of Infrared and Millimeter Waves, 14, 1201, June 1993.

*4. H-X.L. Liu, L.B. Sjogren, C.W. Domier, N.C. Luhmann, Jr., D.L. Sivco and A.Y. Cho, "Monolithic Quasi-Optical Frequency Tripler Array with 5 Watt Output Power at 99 GHz," Electron Device Letters, 14, 329, July 1993.

*5. L.B. Sjogren, H-X.L. Liu, X-H. Qin, C.W. Domier and N.C. Luhmann, Jr., "A Polarization Approach for Quasioptical Phase Measurement," Microwave and Optical Technology Letters, 5, 623, November 1993.

*6. L.B. Sjogren, H-X.L. Liu, F. Wang, T. Liu, X-H. Qin, W. Wu, Esther Chung, C.W. Domier and N.C. Luhmann, Jr., "A Monolithic Diode Array Millimeter-Wave Beam Transmittance Controller." IEEE Transactions on Microwave Theory and Techniques, 41, 1782, (1993).

*7. L.B. Sjogren, H-X.L. Liu, X-H. Qin, C.W. Domier and N.C. Luhmann, Jr., "Phased Array Operation of a Diode Grid Impedance Surface," IEEE Transactions on Microwave Theory and Techniques, 42, 565-572, April 1994.

*8 . C. W. Domier, Luhman, N. C. Jr., Chou, A. E., Zhang, W-M., Romanowsky, A. J., "Ultrashort-Pulse Reflectometry," Rev. of Scientific Instruments, 66, No. 1, pp. 399-401, January 1995.

*9. R.P. Hsia, W.R. Geck, S. Cheng, W-M. Zhang, C.W. Domier, and N.C. Luhmann, Jr., "ECE Imaging Array Diagnostic Development of TEXT-U," Review of Scientific Instruments 66, 834-836, January 1995.

*10. H. Shi, W-M. Zhang, C.W. Domier, N.C. Luhmann, Jr., L.B. Sjogren and H-X.L. Liu, "Novel Concepts for Improved Nonlinear Transmission Line Performance," IEEE Transactions on Microwave Theory and Techniques, 43, 780-789, April 1995.

*11. L. B. Sjogren, L. B., Liu, H.-X. L., Qin, X.-H., Domier, C. W., Luhman, N. C., Jr., "Measurement-Based Model Parameters for Quasi-Optical Electron Device Arrays," lEEE Transaction on Microwave Theory and Technique, 43, No. 4, pp. 899-901, April 1995.

*12. H. Shi, C.W. Domier, N.C. Luhmann, Jr., "A New Monolithic Nonlinear Transmission Line System for Experimental Study of Lattice Solitions," Journal of Applied Physics, 78, No. 4, August 1995, pp.2558-2564.

II. LIST OF JSEP CONFERENCE PROCEEDINGS (*JSEP Supported in Whole or in Part)

*1. W-M. Zhang, H. Shi, C.W. Domier, N.C. Luhmann, Jr.,"GaAs Nonlinear Transmission Lines Using Schottky Superlattice Barrier Varactors,' Presented at the 17th International Conference on Infrared and Millimeter Waves, Pasadena California, Dec. 14-18, 1992.

*2. E.I. Chung, H-X.L. Liu, C. Domier, N.C. Luhmann, Jr.,"High Power Millimeter-Wave Quasi-Optical Frequency Tripler Arrays Using Resonant Tunneling Devices," Presented at the 17th International Conference on Infrared an, Millimeter Waves, Pasadena, California, Dec. 14-18, 1992.

*3. L.B. Sjogren, H-X.L. Liu, F. Wang, T. Liu, X-H. Qin, E. Chung, C.W. Domier, N.C. Luhmann, Jr., "New Developments for Monolithic Millimeter-Wave Diode Array Beam Controllers," Presented at the 17th International Conference on Infrared and Millimeter Waves, Pasadena, California, Dec. 14-18, 1992.

*4. Liu, T., Qin, X-H., Wang, F., Sjogren, L.B., Domier, C.W., and Luhmann, N.C., Jr., "New Developments in Millimeter-Wave Beam Control Arrays," 18th Intl. Conf. on Infrared and millimeter waves, Essex, U.K., September 6-10, 1993.

*5. S. Shu, X-H. Qin, H-X. Liu, C.W. Domier and N.C. Luhmann, Jr., "Monolithic GaAs and InP Based Frequency Multiplier Arrays," Asia-Pacific Microwave Conference 1993, Hsinchu, Taiwan, Oct. 18-21, 1993.

*6. Y. Liu, L.B. Sjogren, F. Wang, C.W. Domier and N.C. Luhmann, Jr., "Millimeter-Wave Schottky Diode Beam Control Arrays," Asia-Pacific Microwave Conference 1993, Hsinchu, Taiwan, Oct. 18-21, 1993.

*7. X-H. Qin, E.I. Chung, C.W. Domier and N.C. Luhmann, Jr.,"High Power Quasi-Optical Millimeter-Wave Sources Using Resonant Tunneling Devices," Asia-Pacific Microwave Conference 1993, Hsinchu, Taiwan, Oct. 18-21, 1993.

*8. W-M. Zhang, H. Shi, C.W. Domier and N.C. Luhmann, Jr., "Monolithic Nonlinear Transmission Lines for Short Pulse and Harmonic Generation," Asia-Pacific Microwave Conference 1993, Hsinchu, Taiwan, Oct. 18-21, 1993.

*9. X. Qin, W-M. Zhang, J.Y. Liao, R.P. Hsia, W.R. Geck, C. W. Domier, N.C. Luhmann, Jr., W. Berk, S. Duncan, and D.W. Tu, "Monolithic Millimeter-Wave Beam Control Grid" 5th Intl. Symp. on Space Terahertz Technology, Ann Arbor, Michigan, May 10-12, 1994.

*10. W-M. Zhang, X. Qin, J.Y.Liao, R.P. Hsia, W.R. Geck, F. Jiang, Y. Li, C.W. Domier and N.C. Luhmann, Jr., "Monolithic Nonlinear Transmission Lines Using Multi-Barrier Devices," 5th Intl. Symp. on Space Terahertz Technology, Ann Arbor, Michigan, May 10-12, 1994.

11. R.P. Hsia, W.R. Geck, S. Cheng, W-M. Zhang, C.W. Domier, and N.C. Luhmann, Jr., "ECE Imaging Array Diagnostic Development for TEXT-U," 10th Topical Conference on High Temperature Plasma Diagnostics, Rochester, NY, May 8 12, 1994.

12. N. C. Luhamm, Jr., "UC Davis High Power Microwave and Millimeter Wave Source Development Program," Intl. Conf. on Plasma Science and Technology, Chengdu, China, June 16-20, 1994. (Invited keynote address)

13. N. C. Luhamann, Jr., "UC Davis Millimeter and Submillimeter Wave Diagnostic Development for Large Plasma Devices," Intl. Conf. on Plasma Science and Technology, Chengdu, China, June 16-20, 1994. (Invited keynote address)

*14. W-M. Zhang, X. Qin, RP. Hsia, RW. Geck, J.Y. Liao, F. Jiang, Y. Li, C. W. Domier, N.C. Luhmann, Jr., "Ultrashort Pulse Reflectometry for Plasma Diagnostics," Intl. Conf. on Plasma Science and Technology, Chengdu, China, June 16-20, 1994.

*15. X. Qin, W-M. Zhang, J.Y. Liao, L.B. Sjogren, C. W. Domier, N.C. Luhmann, Jr., "Monolithic Integrated Beam Control Grid," Intl. Conf. on Plasma Science and Technology, Chengdu, China, June 1~20, 1994.

*16. W-M Zhang, Xiaohui Qin, J.Y. Liao, W.R Geck, C. W. Domier, R.P. Hsia, F. Jiang, Y. Li and N.C. Luhmann, Jr., "Studies on Device Design for Nonlinear Transmission Lines Employing Multi-Quantum Barrier Varactors," 19th Intl. Conf. on Infrared and Millimeter Waves, Sendai, Japan, Oct. 17-21 1994.

*17. J.Y. Liao, X. Qin, W-M. Zhang, C.W. Domier and N.C. Luhmann, Jr., "High Power Submillimeter Wave CW Frequency Multipliers," 19th Intl. Conf. on Infrared and Millimeter Waves, Sendai, Japan, Oct.. 17-21, 1994.

18. X. Qin, W-M Zhang, J.Y. Liao, W.R. Geck, F. Jiang, Y. Li, RP. Hsia, C. W. Domier, N.C. Luhmann, Jr., W. Berk, S. Duncan, and D.W. Tu, "Monolithic Planar Millimeter-Wave Beam Control Array," 19th Intl. Conf. on Infrared and Millimeter Waves, Sendai, Japan, Oct. 17-21 1994.

19. X. Qin, W-M. Zhang, W.R Geck, Fan Jiang, C. W. Domier, N.C. Luhmann, Jr., W. Berk, S. Duncan, and D.W. Tu, "Design Optimization of Monolithic Quasi-Optical Schottky Varactor Beam Control Grid Arrays, 6th Intl. Symp. on Space Terahertz Technology, Pasedena, CA, March 21-23, 1995.

20. W-M. Zhang, Xiaohui Qin, Fan Jiang, Ge Song, Yang Li, C.W. Domier, N.C. Luhmann, Jr., "Nonlinear Transmission Lines and Applications", 6th Intl. Symp. on Space Terahertz Technology, Pasedena, CA, March 21-23, 1995.

*21. RP. Hsia, W.R. Geck, F. Jiang, W-M. Zhang, C. W. Domier, N.C. Luhmann, Jr., "ECE Imaging Arrays for TEXT-U," The Ninth Joint Workshop on Electron Cyclotron Emission and Electron Cyclotron Resonance Heating, Borrego Springs, CA, January 22-26, 1995.